

# Texas Fire Meteorology Research:

Proximity Observations for Wind-Driven Grassland Wildfire Starts

Composites for Southern Great Plains Wildfire Outbreaks

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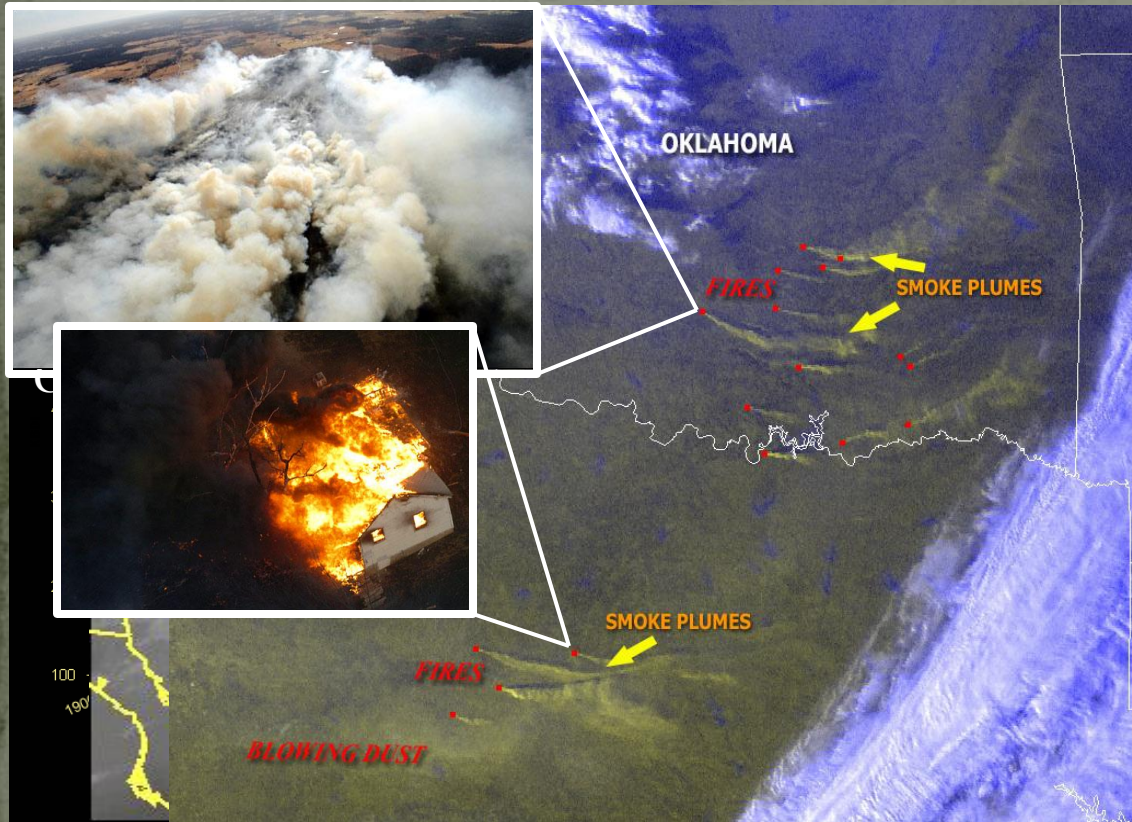
NOAA/NWS Lubbock, Texas



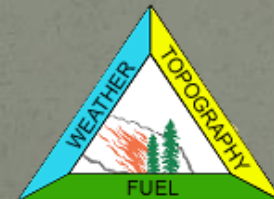
Texas Statewide Fire Weather Meeting  
College Station, Texas ~ 7 December 2010

# Motivation: *for intensive fire meteorology research in Texas*

an increase in damaging wildfire activity since the mid 1990s



- multi-decadal drought
- increased population
- changing land usage
- wildfires driven by weather
- a prolific natural hazard in Southern Great Plains since 2005





# *What is the Wildfire - Weather relationship ?*

how do wind-driven grassland wildfire environments differ from the more widely-studied forest fires?



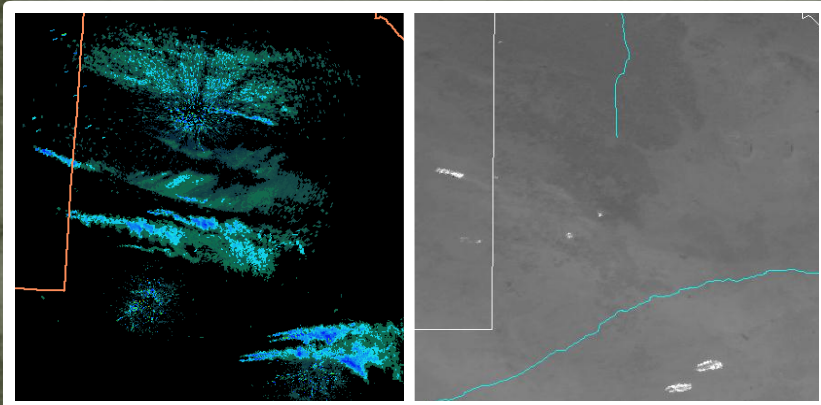
do Red Flag Warnings accurately predict fire environments ?

what are “critical” fire weather conditions ?



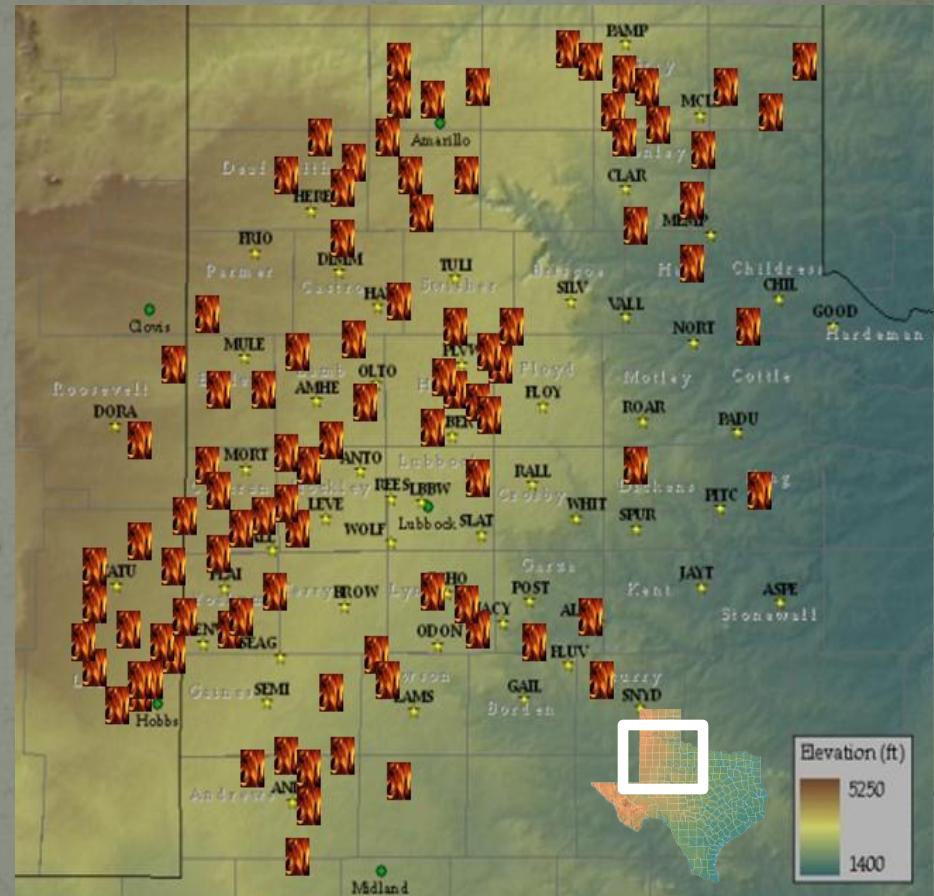
# Quantifying the near-fire weather

- collected WTM proximity observations for 99 severe wildfires Jan 2006 – May 2010
- “severe” defined  $\geq 300$  acres
- fire start time/location determined by remote sensing
- collected 5 minute WTM observations



## radar “smoke plumes”

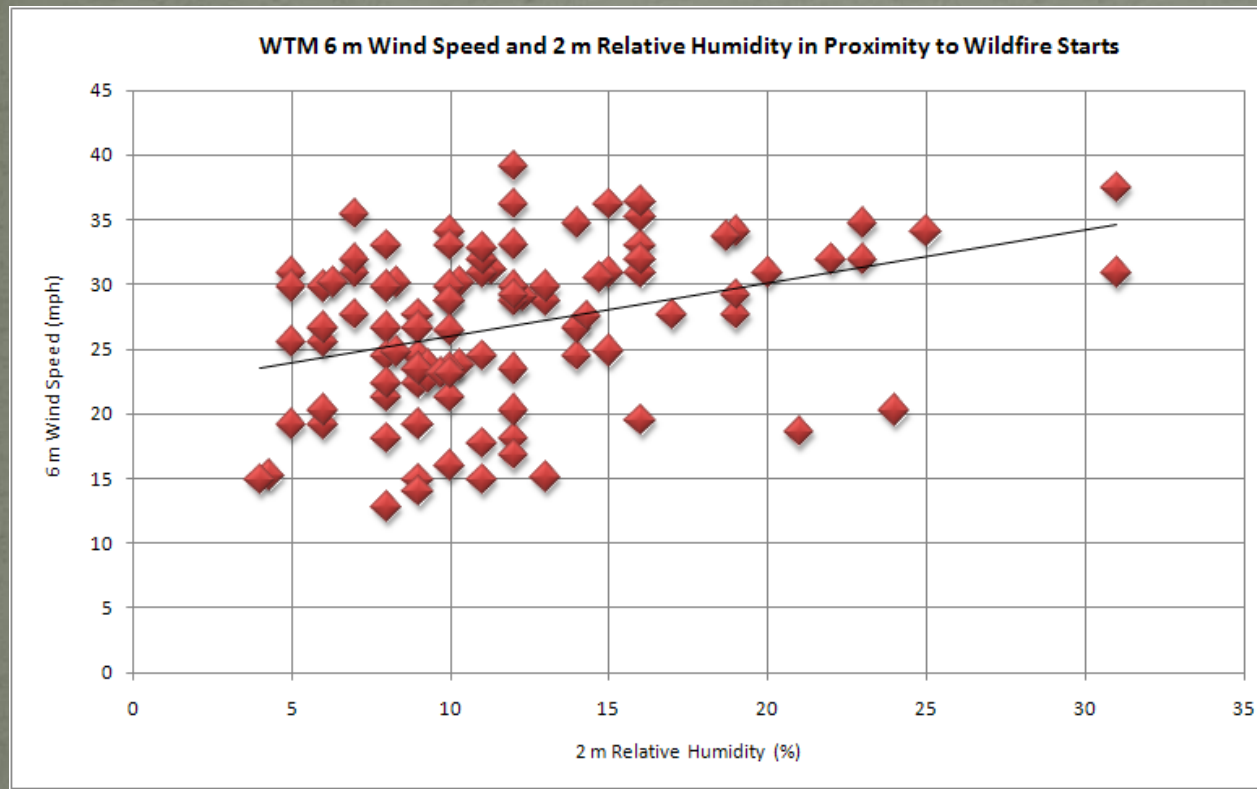
## satellite “hot spots”





# Relative Humidity & Wind Speed:

most commonly used predictive meteorological variables for fire behavior

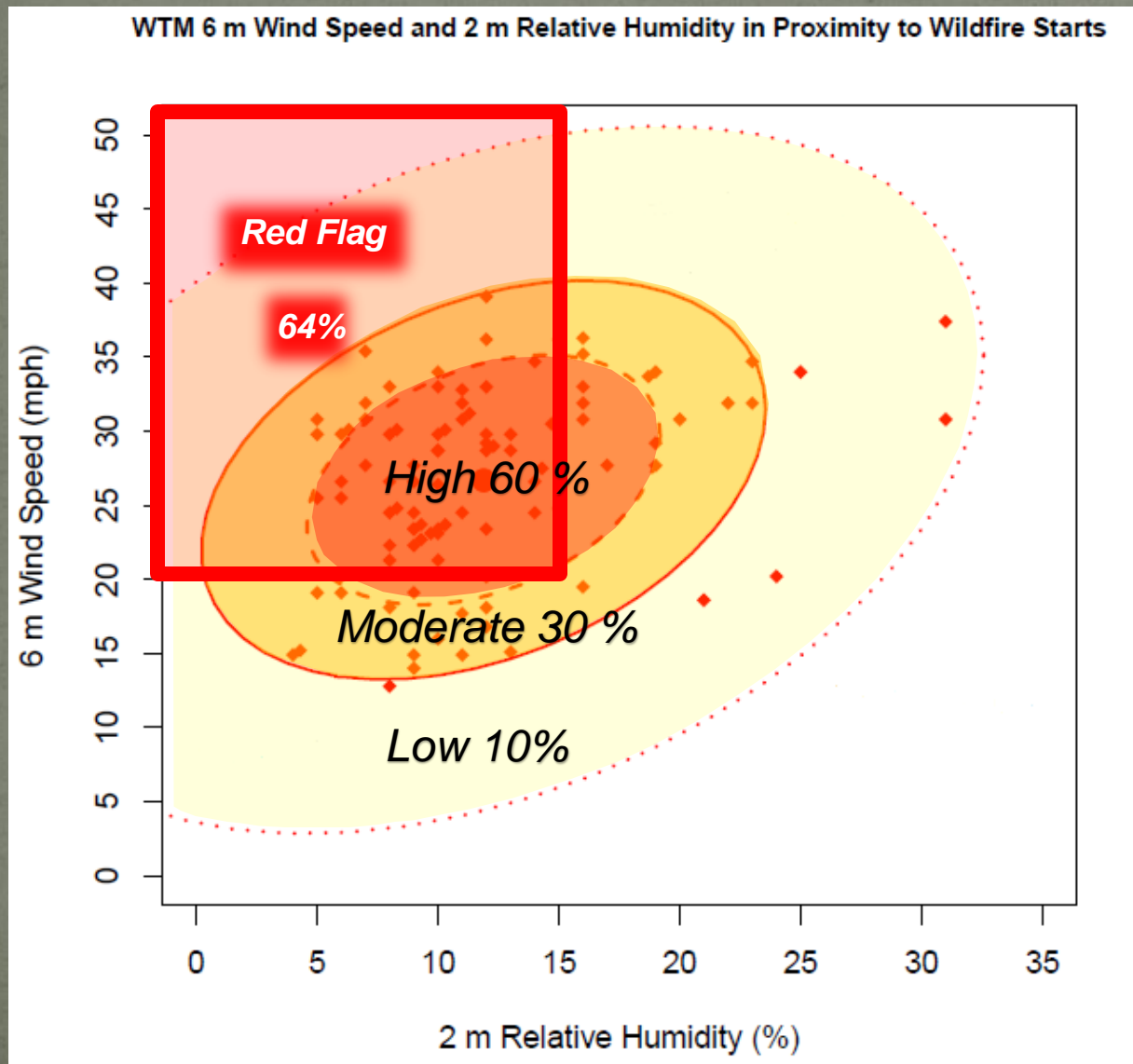


- combinations of humidity & wind near fire starts have a slight linear relationship

$$P=0.36 \quad r=0.003$$

- statistical mean:  
RH=12%  
WS=27 mph

# Relative Humidity & Wind Speed:



- statistically quantify the frequency of wildfire development per specific RH & WS environments
- critical combinations of RH & WS do not conform to a rigid criteria
- Red Flag criteria accounts for 64% of wildfire environments

# Relative Humidity & Wind Speed:

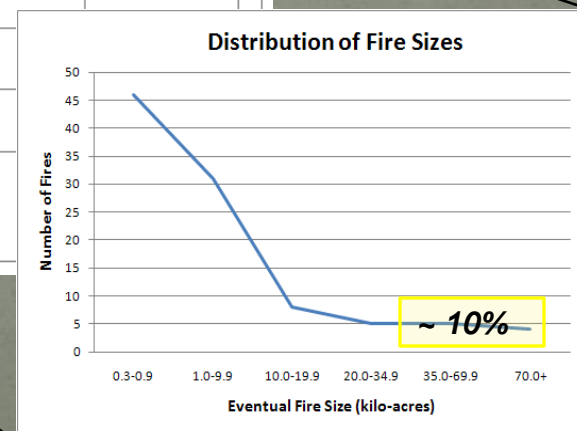
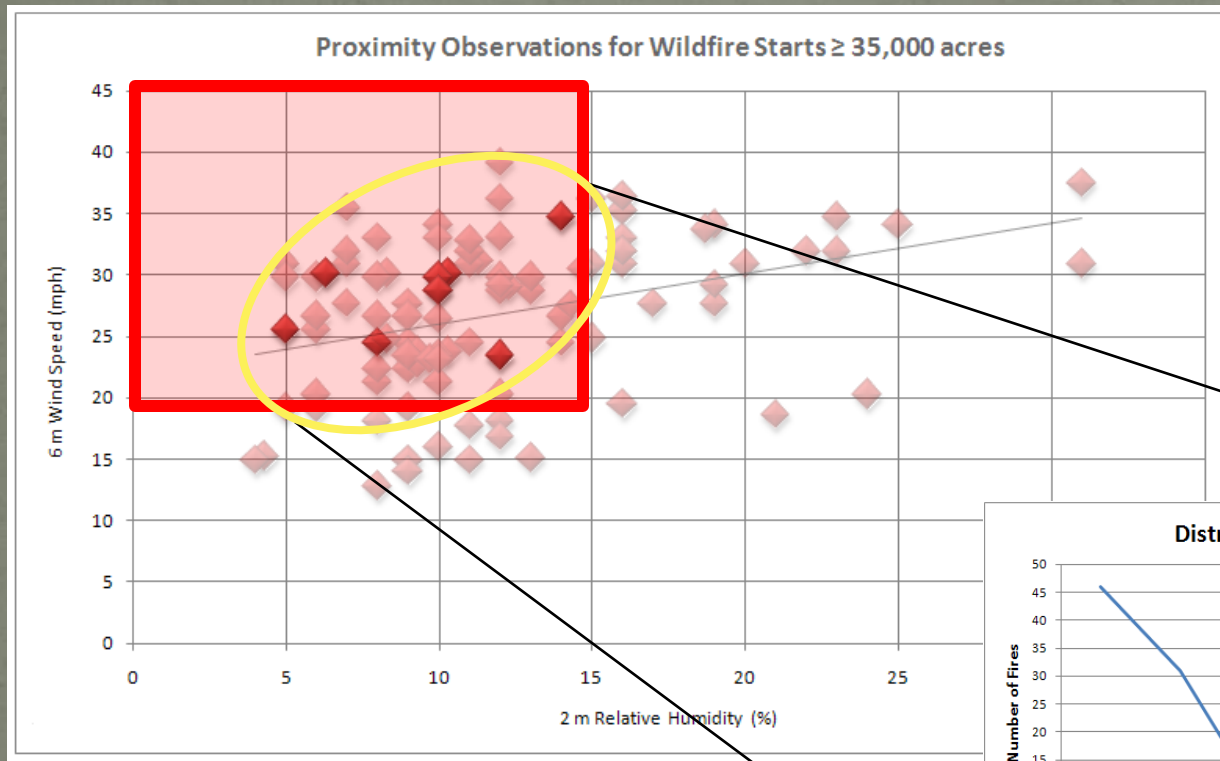
differentiate starts by eventual fire size

- Red Flag criteria (Region III):

$$RH \leq 15\%$$

$$WS \geq 20 \text{ mph}$$

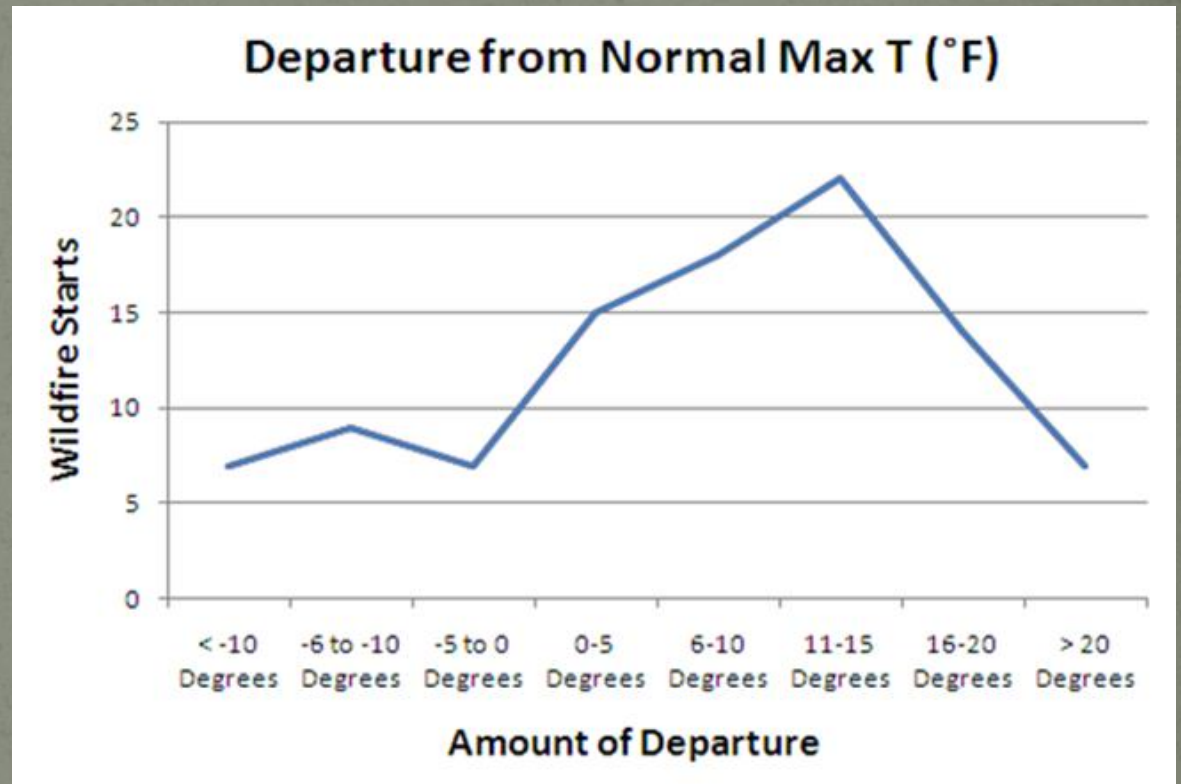
- accounts for a majority & most extreme wildfire starts





# Temperature:

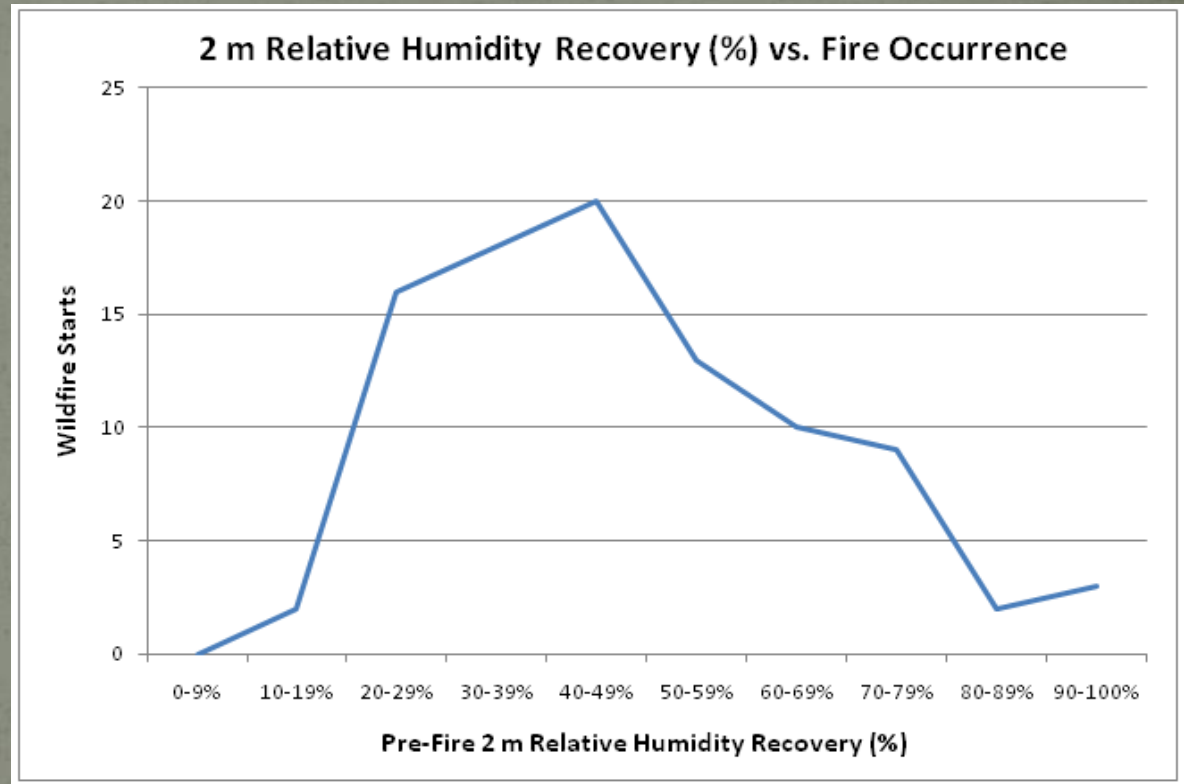
- grassland wildfires can occur in any temperatures
- peak in occurrence when temperatures are above seasonal averages





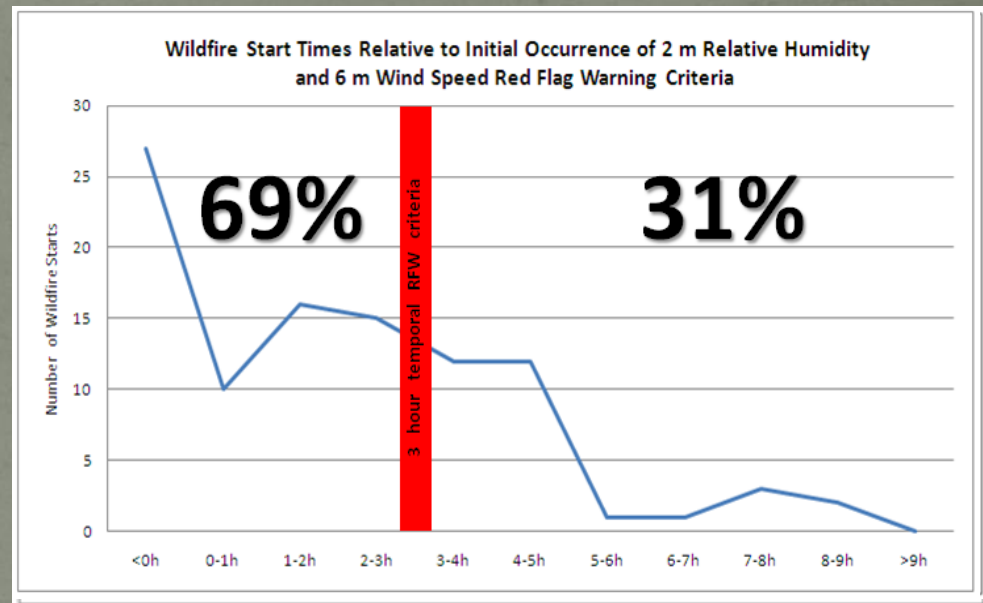
# Relative Humidity Recovery:

- RH recovery is proxy for fine fuel moisture before the diurnal burn period
- grassy fuels respond quickly to near-surface weather...cure within a few hours
- high RH recoveries limit significant fire starts, but do not preclude them
- low RH recoveries ensure fuel moisture is too low to resist fire



# Climatological Trends:

- wind-driven grassland fires peak winter-early spring
- starts peak around midday
- most fire starts occur very soon after onset of critical weather





# COMMENTS ON FIRE STARTS

- **Red Flag Warnings used to identify “critical” combinations of dry fuels and weather that support extreme fire behavior**

What better way to verify “critical” conditions than with observed wildfire evolution ?

- **Most dangerous starts in Southern Plains are non-meteorological in environments favorable for wind-driven fires**
  - utility lines – 40 mph G60 mph
  - vehicles...cars, trucks, and trains
  - cigarettes
  - welding/outdoor construction
  - outdoor lighting
  - re-ignition of old burns
  - arson

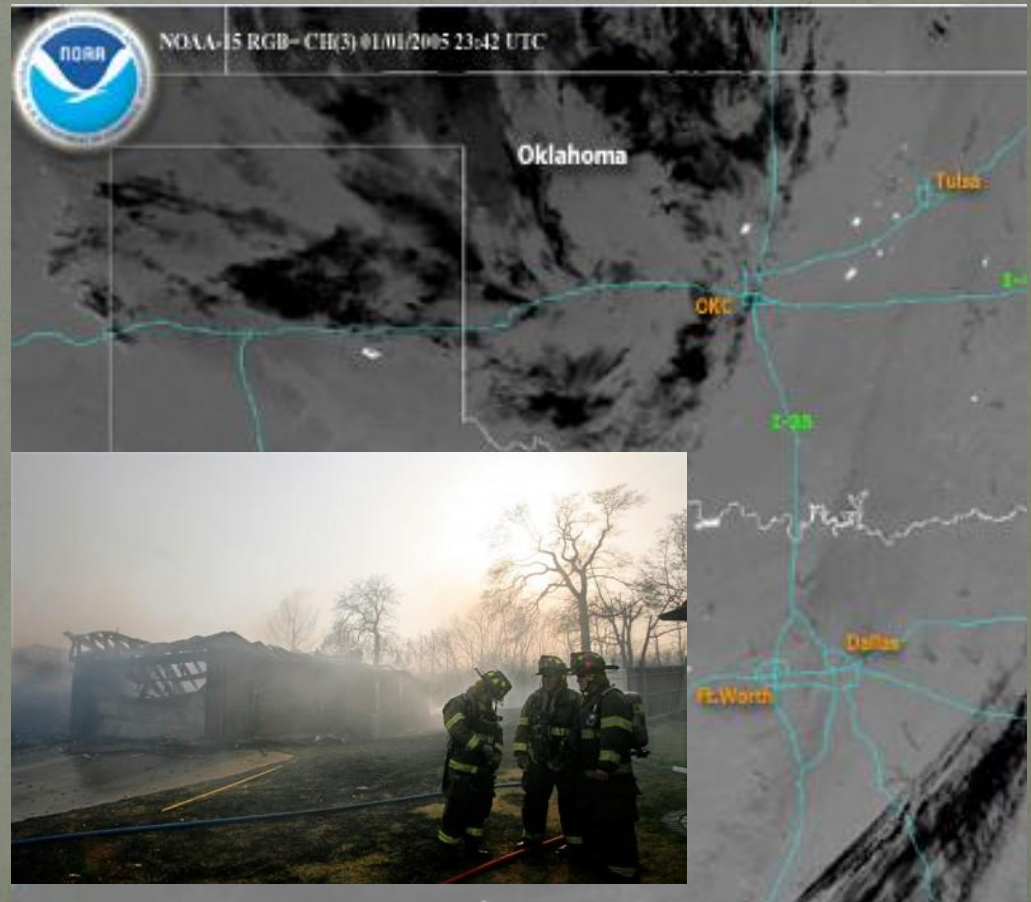


Since late 2005... fire activity peaked in the Southern Plains during 10 “outbreaks”

## *Are these dangerous fire weather patterns predictable ?*

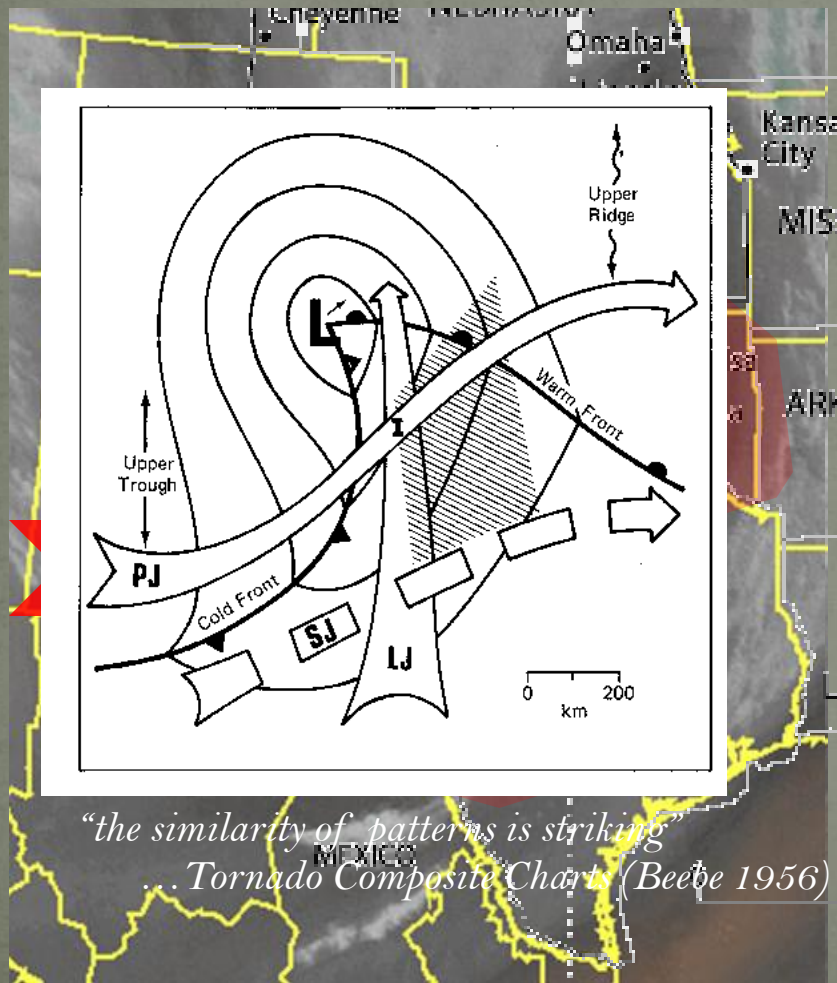
### devastating public impacts:

- more than 200 major wildfires
- 2.6 million acres burned
- 1,000+ structures destroyed
- 24 deaths and 166 injuries

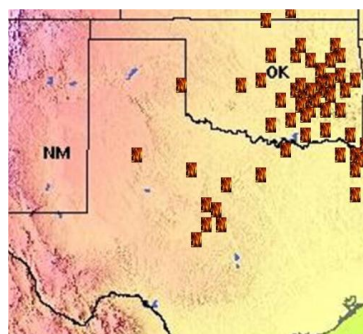




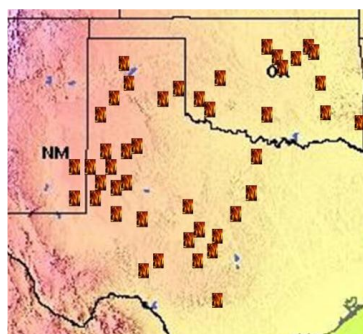
Texas wildfire outbreaks were quickly recognized to be associated with the passage of intense upper air storms and winds



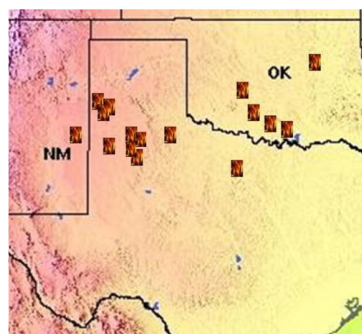
- Impacted large spans of eastern New Mexico, Texas, Oklahoma – the Southern Great Plains
- the synoptic scale pattern was known and highly-predictable, but specific processes involved were not
- a composite methodology was used to identify common/key atmospheric features...their relative location and magnitude
- composites analogous to early efforts toward ingredient-based forecast methodologies for severe storms



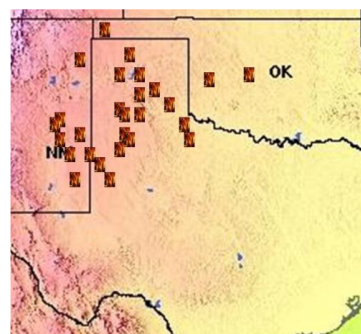
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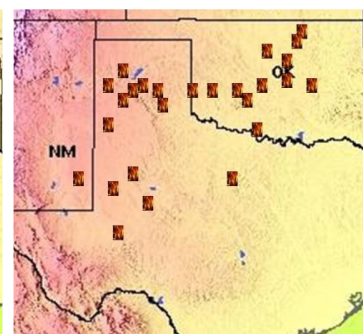
1 Jan 2006



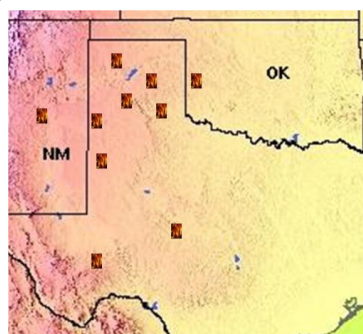
12 Jan 2006



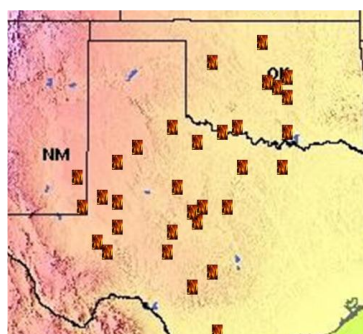
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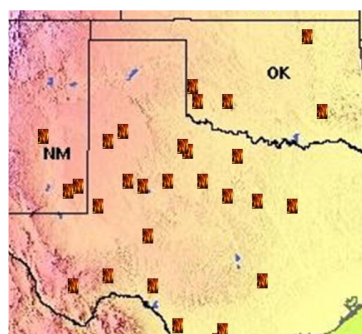
6 Apr 2006



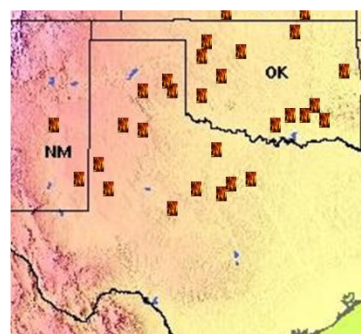
15 Apr 2006



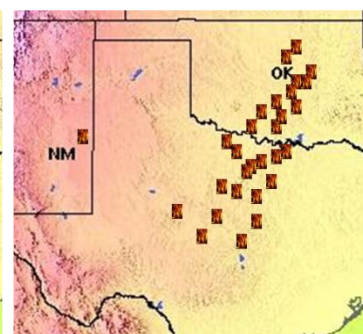
25 Feb 2008



14 Mar 2008

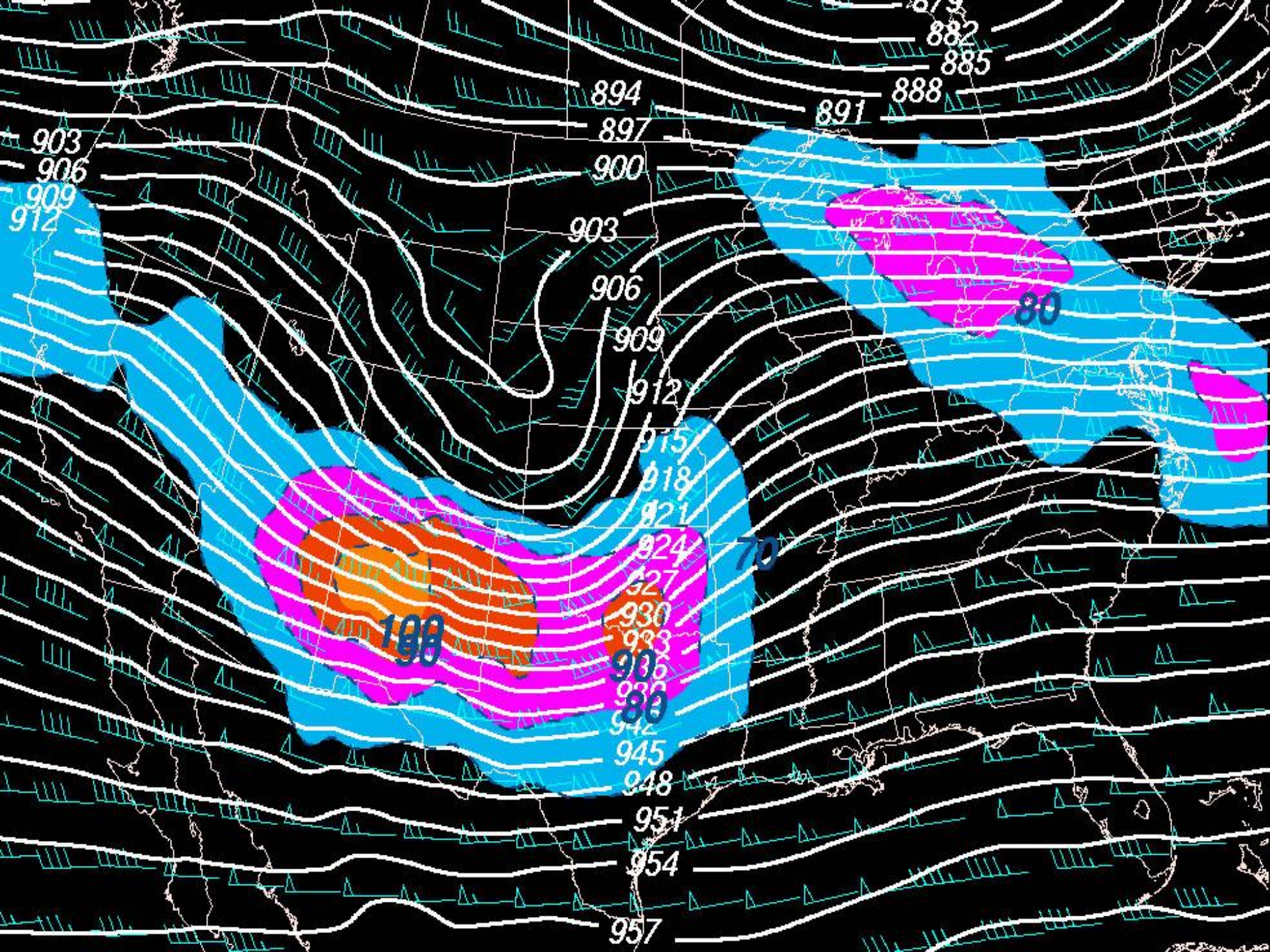


4 Apr 2009



9 Apr 2009



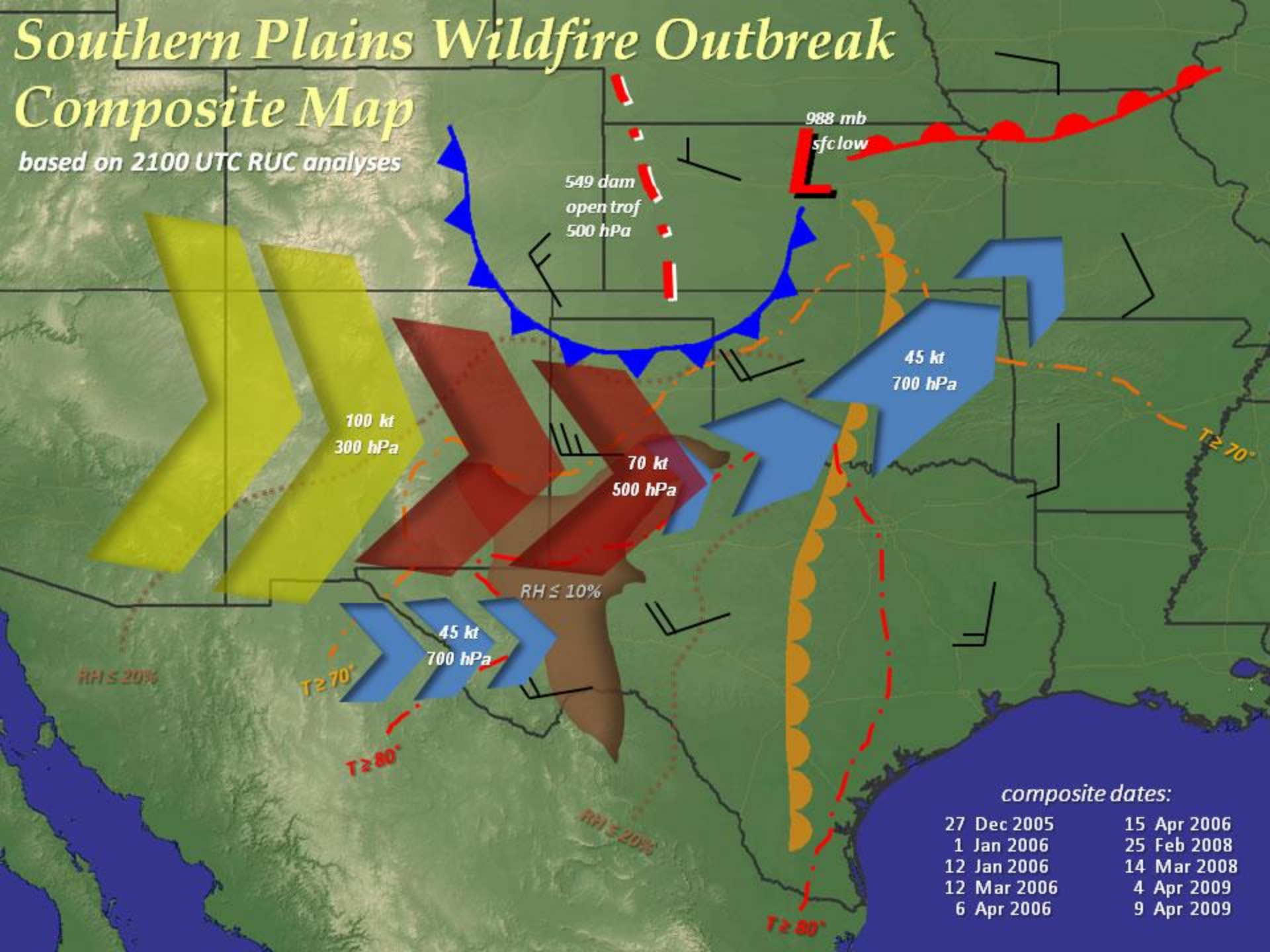




# Southern Plains Wildfire Outbreak

## Composite Map

based on 2100 UTC RUC analyses



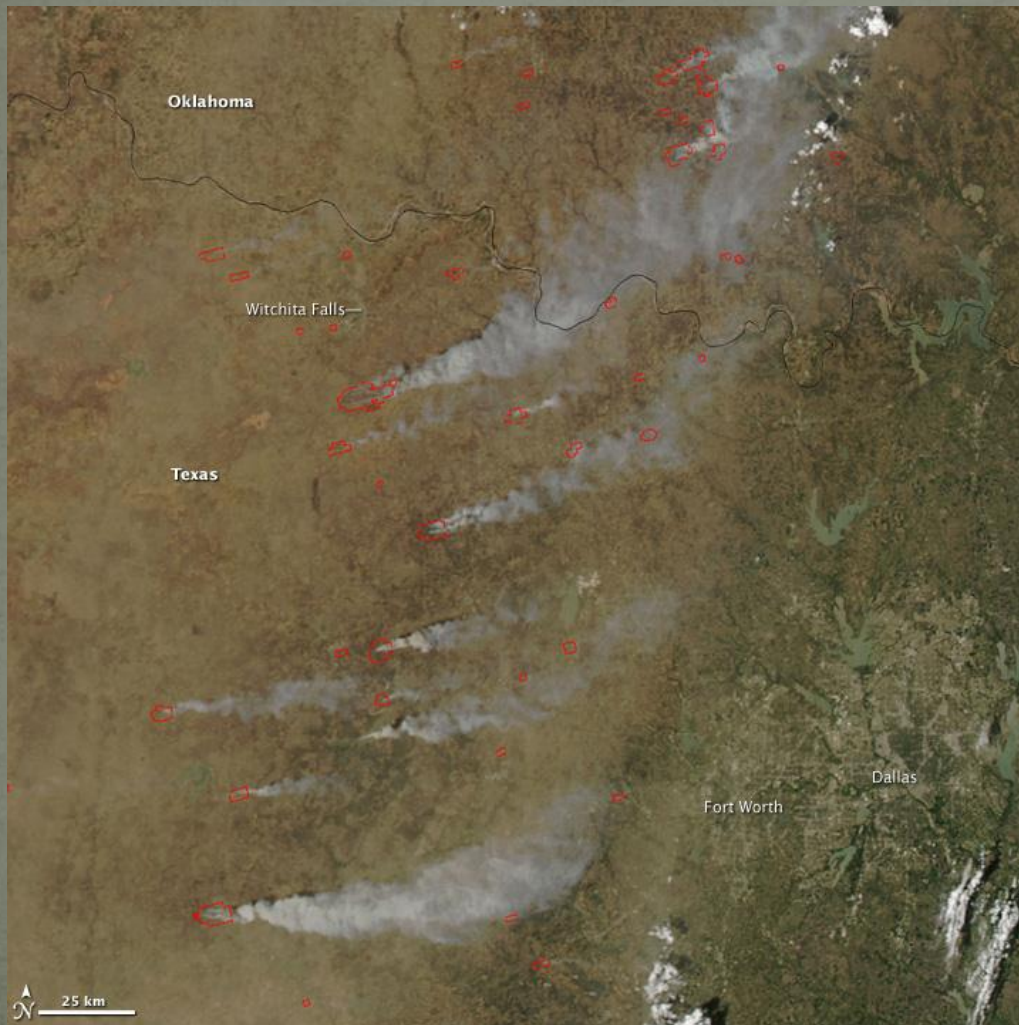
composite dates:

27 Dec 2005	15 Apr 2006
1 Jan 2006	25 Feb 2008
12 Jan 2006	14 Mar 2008
12 Mar 2006	4 Apr 2009
6 Apr 2006	9 Apr 2009



# Review: 9 April 2009 Wildfire Outbreak

## A Texas & Oklahoma Wildland Fire Disaster



- at least 29 major fires
- 235,792 acres burned

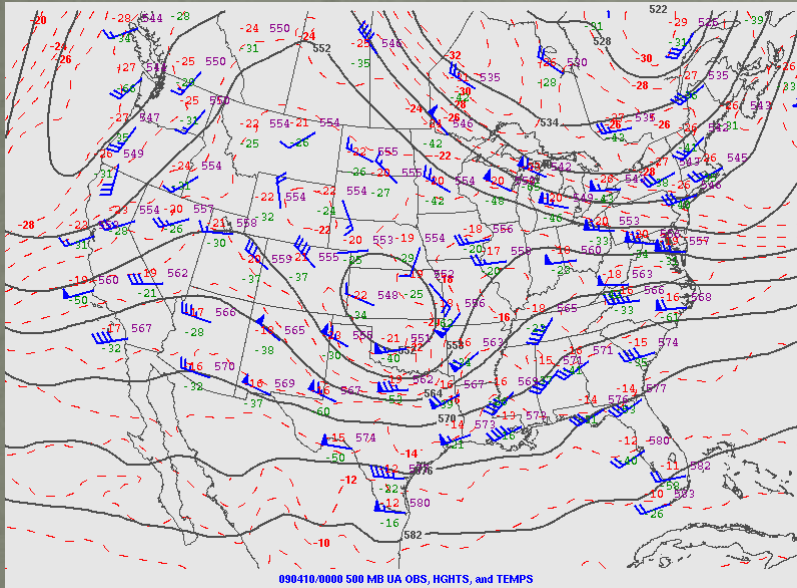


- 339 structures destroyed
- 4 dead – 62 injured

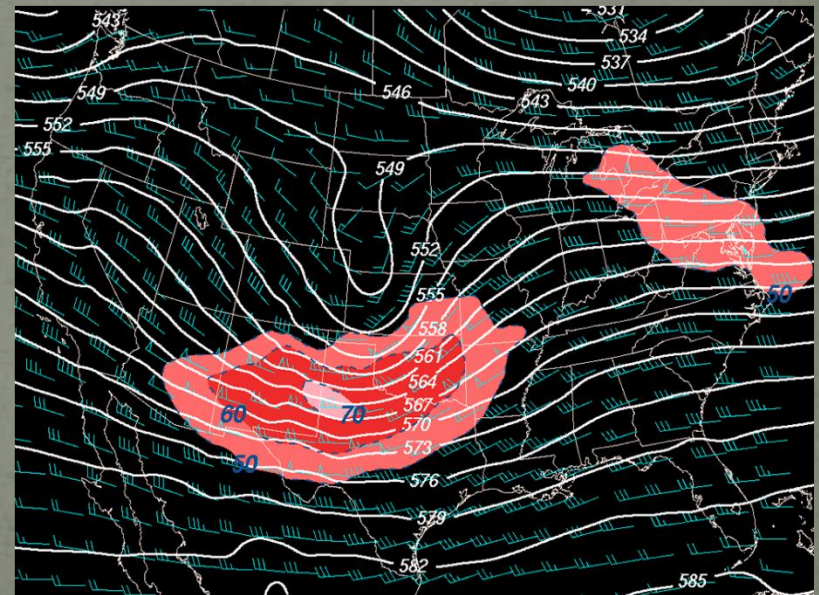


# Review: 9 April 2009 Wildfire Outbreak

## Synoptic Composite-Like Pattern



500 mb - observed

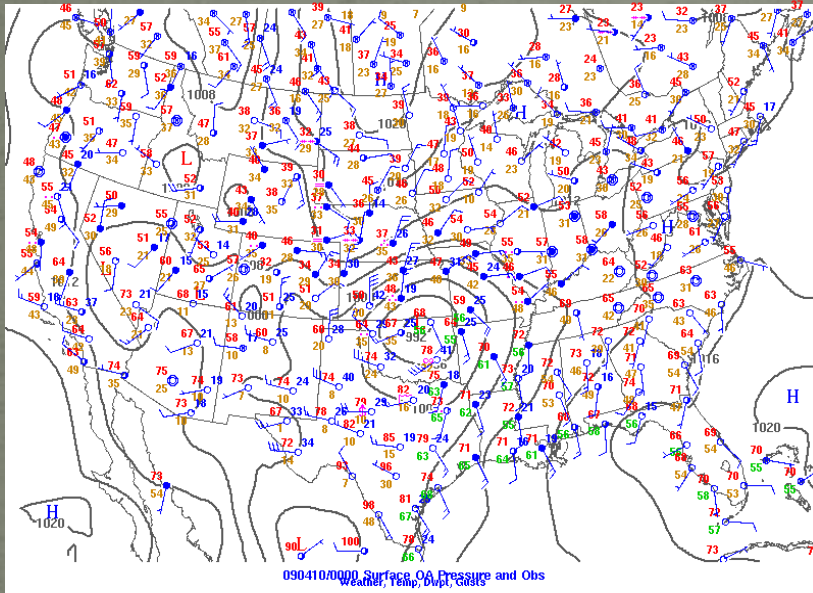


500 mb - composite

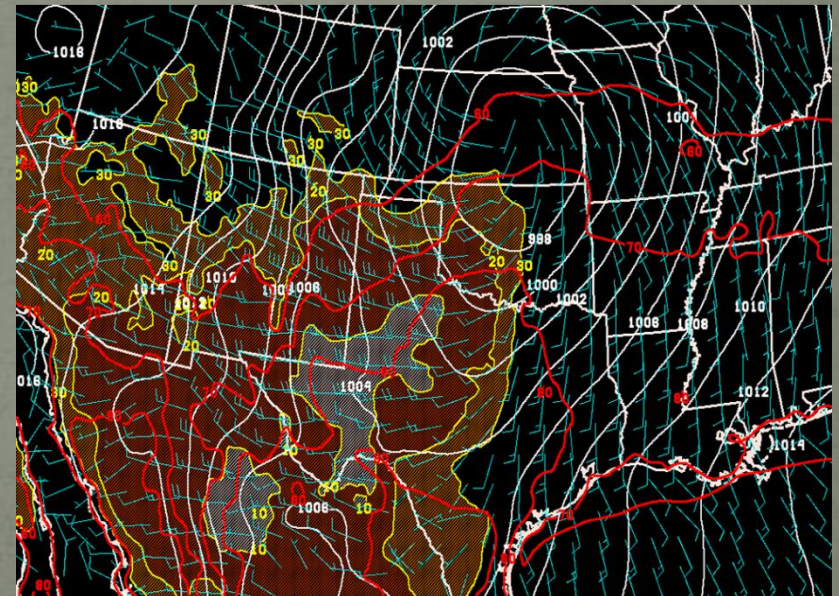


# Review: 9 April 2009 Wildfire Outbreak

## Synoptic Composite-Like Pattern



surface - observed



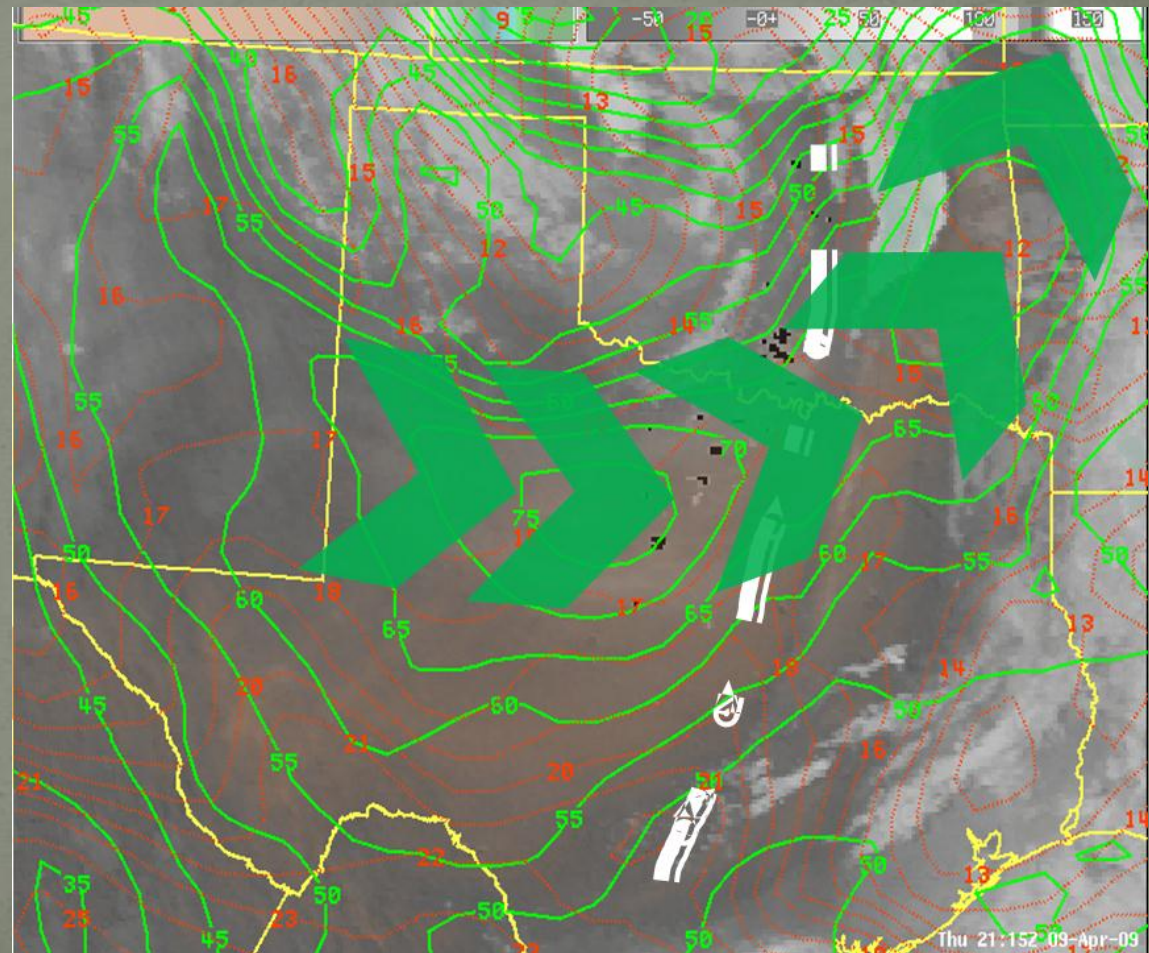
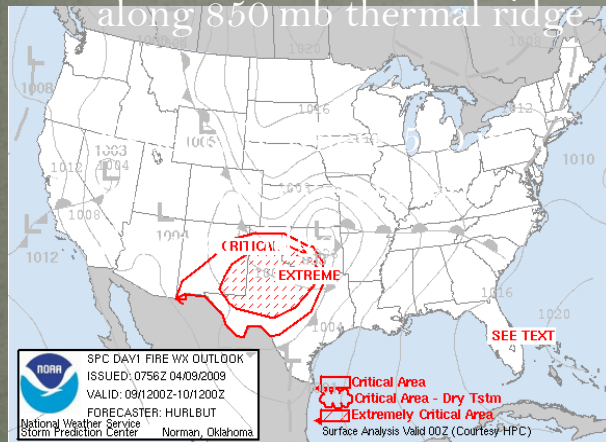
surface - composite



# Review: 9 April 2009 Wildfire Outbreak

## Mesoscale Pattern & Fuels

- apply categorical frequencies from proximity obs study
- apply fuel intelligence
- apply temperature analysis
- fire activity concentrated along 850 mb thermal ridge

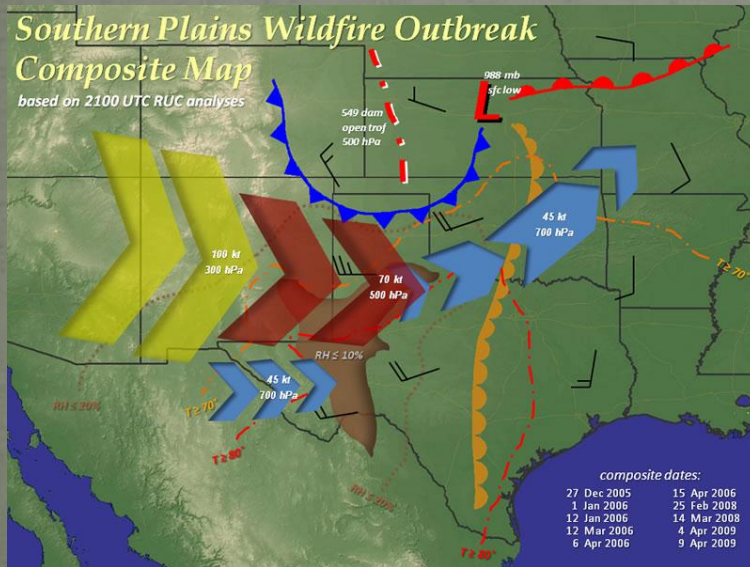




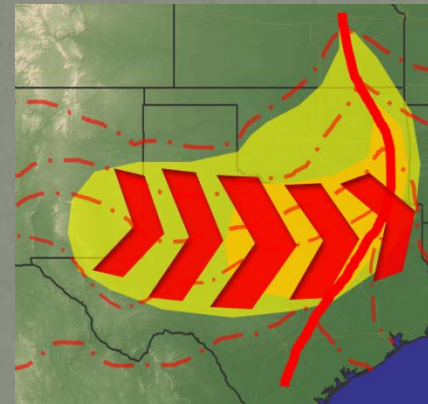
# Review: 9 April 2009 Wildfire Outbreak

Keystone event that helped narrow geographical areas of heightened risk within synoptic composite-like patterns

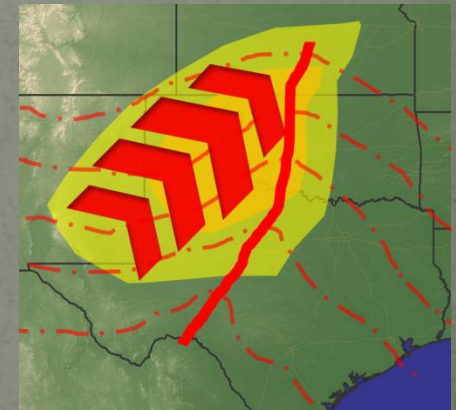
- composite is an average of 10 outbreaks in the Southern Great Plains
- two thermal/wind configurations that help focus scope of highest risk



composite



normal



near parallel

# Future Work:

- very little is known about fire meteorology in the Southern Great Plains grasslands
- complexity of atmosphere/biofuel interactions
- forecasters continuously ask for fuel intel
- improve NWS fire weather services via the introduction of observations/science



<http://www.srh.noaa.gov/lub/?n=science-wtefirewx>

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